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Gini Coefficients for Subsidy Distribution in Agriculture

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GINI COEFFICIENTS FOR SUBSIDY DISTRIBUTION IN AGRICULTURE

1. INTRODUCTION

This note seeks to quantify inequality in the distribution of 2000 and 2001 agricultural subsidies for France, Great Britain, the European Union and the United States using gini coefficients and associated Lorenz curves. Because the subsidy data are available only in aggregate form, a parametric extrapolation technique for grouped data is employed. For comparative purposes, the results are compared with similar measures for the distribution of income in Brazil, identified as one of the world's most unequal countries in the 2004 World Bank *World Development Report*. The results, which are Lorenz consistent, show that the dispersion of subsidies in the selected countries and the European Union is far more skewed than the dispersion of income in Brazil. The note will describe the dataset and methodology, then present the results and the conclusions about relative inequality that can be drawn from them. The Appendix gives the original datasets and preliminary calculations used to generate the inequality measures.

2. THE DATASET AND METHODOLOGY

The dataset provides information on 'direct aid to producers', referred to here as farm subsidies, for France, Great Britain and the European Union for the financial years 2000 and 2001, and for the United States for 2001 (see Appendix). The data are given in a highly aggregated form. Farm households are divided into groups based on the size of the subsidy they received. For each group, we are given the mean subsidy and the number of farms receiving subsidies within the range. In calculating inequality indices, this information enables the specification of lower and upper limits of inequality for each group, as well as a compromise measure falling between the two. To calculate the gini coefficient for Brazil, we rely also on grouped data, so that the measures are calculated using similar methods.

The gini coefficient is a measure of income inequality based on the deviation between the actual distribution of income within a population and a hypothetical distribution in which income is distributed completely equally. The actual distribution is represented using a Lorenz curve which is derived by ranking incomes in ascending order, and then plotting the cumulative percentage of total income received against the population share.

For a continuous distribution, the coefficient can be derived by using integration techniques to determine the area between the actual distribution of a population and a completely equal distribution. For discrete distributions, the measure can be calculated by taking one half of the average of the absolute values of differences between all income pairs, such that:

$$G = \frac{1}{2n^2 y} \sum_{i=1}^n \sum_{j=1}^n |y_i - y_j|$$

where i represents the units within a population of size n , y represents income, and j is simply the index of the sum.¹

The measure ranges between zero and one, rendering its interpretation simple: a measure of zero represents complete equality (that each unit receives an equal amount of income), while a measure of one represents complete inequality, indeed that all wealth is concentrated in a single unit. Because the measure is based on distances from the mean, it is much more sensitive to changes in the middle of the distribution than to its ends.

Here we obtain the Lorenz curve coordinates using parametric extrapolation. Research has found that two parametric specifications – the General Quadratic and Beta models – perform better than alternate functional forms in approximating the fit of a Lorenz curve (Datt 1998). We use the World Bank’s POVCAL (Program for Calculating Poverty Measures from Grouped Data) program – designed for group data – to assess the best-fitting of the two functional forms, and to calculate the corresponding gini coefficients using integration techniques (see Chen *et al.* 1991).

3. RESULTS

Table 1 gives gini coefficients for the distribution of farm subsidies in France, Great Britain, the European Union and the United States in 2000 and 2001. These are compared to the gini coefficient for income distribution in Brazil, estimated on the basis of grouped data from 2001.²

Table 1 – Gini measures for distribution of farm subsidies in Europe and the United States, and for the distribution of income in Brazil, 2000 and 2001

COUNTRY	2000	2001
FRANCE	69.5	59.7
GREAT BRITAIN	71.3	75.6
EU-15	77.7	77.3
UNITED STATES		79.2
BRAZIL		60.7

Note: US estimate based on more aggregated data than EU countries (see Appendix).

Coefficients calculated using POVCAL (Program for Calculating Poverty Measures for Grouped Data), see <http://www.worldbank.org/research/povmonitor/software.htm>.

As noted above, the gini coefficient is an inequality measure that stresses the middle of the distribution. It is possible for a country to have a higher gini than a comparator, and nonetheless display greater equality at some points of the distribution. To determine whether one distribution is ambiguously more unequal than another, we turn to an examination of their Lorenz curves. Figure 1 presents Lorenz curves for

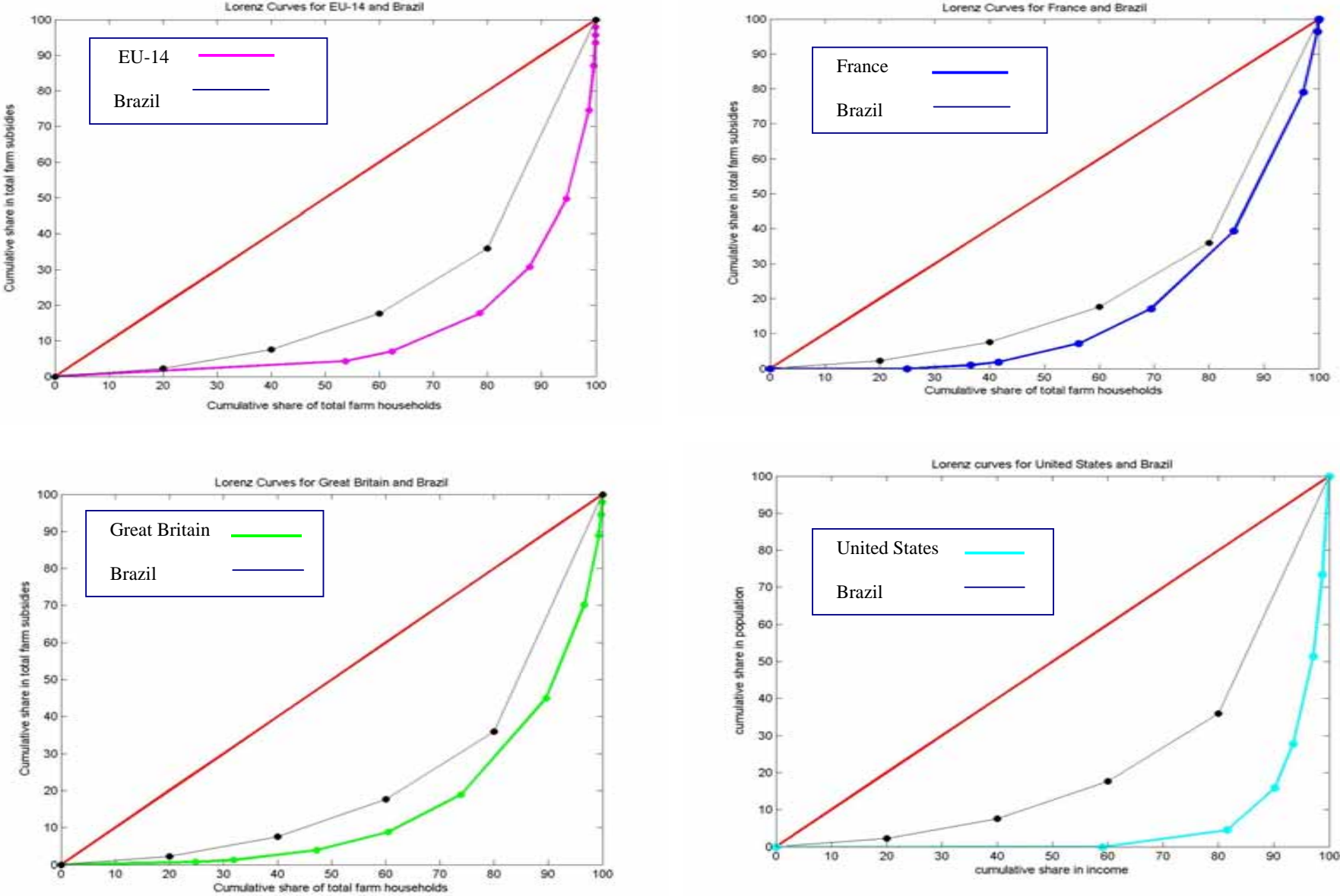
¹ For an overview of the derivation of the gini coefficient for a discrete distribution by estimating lower and upper bounds, and a ‘compromise’ measure, see Cowell 1995, Chapter 5.

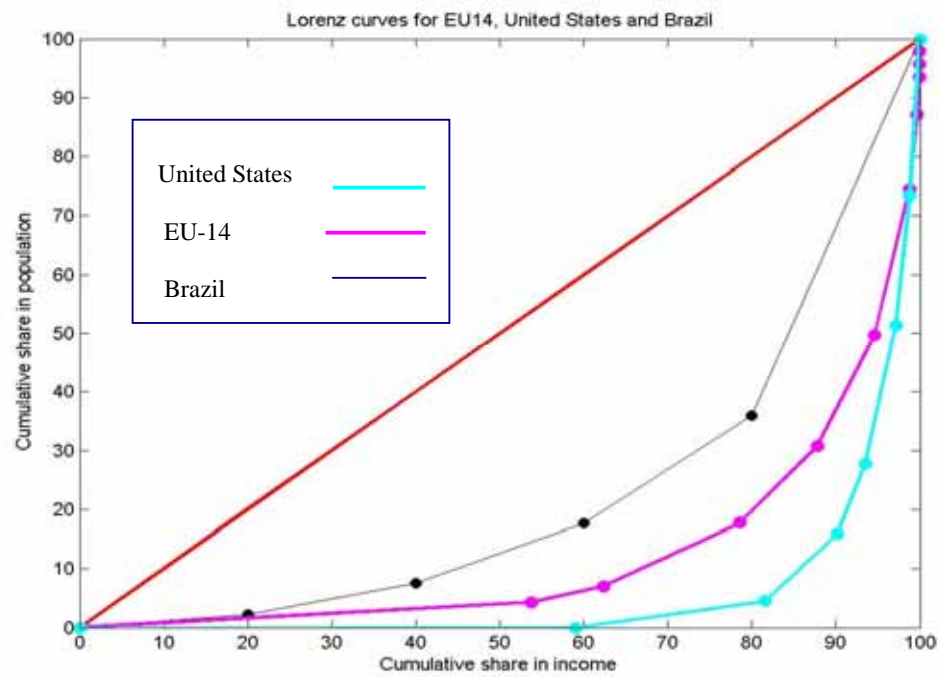
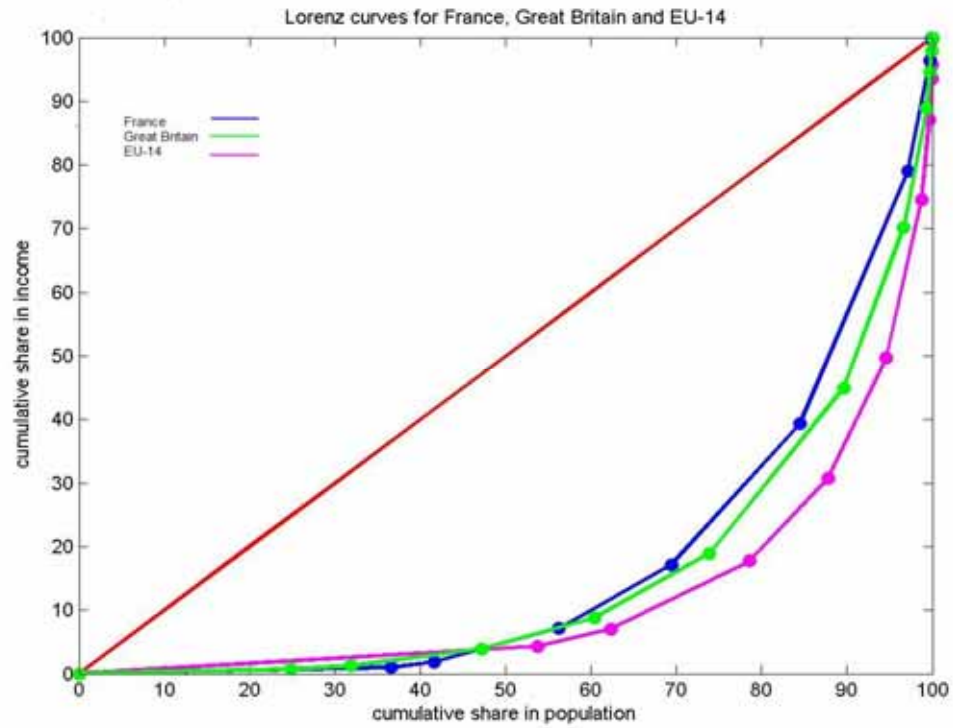
² Based on available data (World Development Indicators 2004), and using estimates from after 1995, Brazil was the second most unequal country after Guatemala. Brazil is chosen as the key comparator here because the country is more widely known to be extremely unequal. The published estimate for Brazil, based on a full set of household survey data, is 59.3. The estimate here, based on grouped data, is 60.7.

2000 (the European countries and EU-14) and 2001 (the United States and Brazil). A distribution can only be said to be categorically more unequal than another if its distribution curve lies wholly within the distribution curve of its comparator.³ Any intersection of curves being compared implies that the inequality ranking will differ depending on the part of the distribution being considered. The Lorenz curves of each country and EU-14 do not intersect with that of Brazil, which allows us to assert that the distribution of the agricultural subsidies among farm households in France, Great Britain, the European Union and the United States is unambiguously more unequal than the distribution of income in Brazil. Lorenz consistency does not always hold for the comparison of the distribution of farm subsidies between the comparator countries, as the penultimate panel, which considers the European countries and European Union, makes clear. This implies that alternative inequality measures highlighting different parts of the distribution would lead to a conflicting ranking of the countries. However, the bottom panel makes clear that the distribution of subsidies in the United States is more unequal than in the European Union, regardless of which part of the distribution is being considered.

³ The Lorenz Dominance Criterion states that one distribution can only be said to be more equal than another when each of its points lies below that of its counterparts. Put formally, given two distributions X and Y , and Lorenz curves $L(p)$, if $L(p)X \geq L(p)Y$ for each $0 \leq p \leq 1$, and $L(p)X > L(p)Y$ for some p , then the distribution X is more equal than distribution Y (Figini 2000).

FIGURE 1 - LORENZ CURVES FOR DISTRIBUTION OF FARM SUBSIDIES IN EU-14, FRANCE, GREAT BRITAIN (2000) AND UNITED STATES (2001) VERSUS DISTRIBUTION OF INCOME IN BRAZIL (2001)





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APPENDIX – DATA AND PRELIMINARY CALCULATIONS

Table A.1 – Data for France, 2000

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
					0.00	0.00	0.000	0.00
	0	149.48	0.00	0.00	25.00	0.00	25.000	0.00
(1)	1 - 1,250	68.99	59,149	857.36	11.54	1.02	36.539	1.02
(2)	1,250 - 2,000	30.44	48,914	1606.90	5.09	0.84	41.630	1.86
(3)	2,000 - 5,000	87.10	306,062	3513.92	14.57	5.26	56.197	7.11
(4)	5,000 - 10,000	78.99	584,865	7404.29	13.21	10.05	69.408	17.16
(5)	10,000 - 20,000	90.33	1,293,254	14316.99	15.11	22.21	84.516	39.37
(6)	20,000 - 50,000	75.48	2,307,930	30576.71	12.62	39.64	97.140	79.02
(7)	50,000 - 100,000	15.47	1,009,830	65276.66	2.59	17.35	99.727	96.36
(8)	100,000 - 200,000	1.55	191,644	123641.29	0.26	3.29	99.987	99.66
(9)	200,000 - 300,000	0.06	13,907	231783.33	0.01	0.24	99.997	99.90
(10)	300,000 - 500,000	0.02	5,431	271550.00	0.00	0.09	100.000	99.99
(11)	500,000 or more	0.00	636	0.00	0.00	0.01	100.000	100.00
	TOTAL	597.91	5,821,622	750,527.45	100.00	100.00		
	Average		529,238	68,229.77				

Source: European Commission.

Table A.2 – Data for France, 2001

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative Frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
(1)	Less than 0	0.13	-77.00		0.00	0.00	0.00	0.00
(2)	0 - 1,250	83.59	43,397	519.16	18.16	0.67	18.16	0.67
(3)	1,250 - 2,000	27.38	43,876	1602.48	5.95	0.68	24.10	1.34
(4)	2,000 - 5,000	71.30	241,128	3381.88	15.49	3.71	39.59	5.05
(5)	5,000 - 10,000	80.29	578,225	7201.71	17.44	8.90	57.03	13.95
(6)	10,000 - 20,000	90.43	1,302,173	14399.79	19.64	20.03	76.67	33.98
(7)	20,000 - 50,000	84.32	2,607,808	30927.51	18.31	40.12	94.99	74.11
(8)	50,000 - 100,000	20.55	1,350,567	65721.02	4.46	20.78	99.45	94.89
(9)	100,000 - 200,000	2.40	296,830	123679.17	0.52	4.57	99.97	99.45
(10)	200,000 - 300,000	0.10	23,882	238820.00	0.02	0.37	99.99	99.82
(11)	300,000 - 500,000	0.02	7,609	380450.00	0.00	0.12	100.00	99.94
(12)	500,000 or more	0.01	4,133	0.00	0.00	0.06	100.00	100.00
	TOTAL (all ranges)	460.52	6,499,551					
	TOTAL (ranges 2 - 12)	460.39	6,499,628	866,702.73	100.00	100.00		
			590,875.27	78,791.16				

Source: European Commission.

Table A.3 – Data for Great Britain, 2000

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative Frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
(1)	Less than 0	0.25	-316				0.00	0.00
(2)	0 - 1,250	69.92	28,106	401.97	33.15	0.89	33.15	0.89
(3)	1,250 - 2,000	16.08	25,812	1605.22	7.62	0.82	40.77	1.71
(4)	2,000 - 5,000	35.55	116,485	3276.65	16.85	3.69	57.63	5.39
(5)	5,000 - 10,000	24.62	174,618	7092.53	11.67	5.52	69.30	10.92
(6)	10,000 - 20,000	22.19	319,366	14392.34	10.52	10.10	79.82	21.02
(7)	20,000 - 50,000	25.92	829,189	31990.32	12.29	26.23	92.11	47.25
(8)	50,000 - 100,000	11.44	789,669	69027.01	5.42	24.98	97.53	72.24
(9)	100,000 - 200,000	4.19	561,339	133971.12	1.99	17.76	99.52	89.99
(10)	200,000 - 300,000	0.69	163,051	236305.80	0.33	5.16	99.84	95.15
(11)	300,000 - 500,000	0.26	95,882	368776.92	0.12	3.03	99.97	98.19
(12)	500,000 or more	0.07	57,333	819042.86	0.03	1.81	100.00	100.00
					0.00	0.00		
	TOTAL (all ranges)	211.18	3,160,534					
	TOTAL (ranges 2 - 12)	210.93	3,160,850	1,685,882.74	100.00	100.00		

Source: European Commission.

Table A.4 – Data for Great Britain, 2001

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
							0.00	0.00
(1)	0 - 1,250	41.28	22,508	545.25	24.82	0.70	24.82	0.70
(2)	1,250 - 2,000	11.66	18,539	1589.97	7.01	0.58	31.82	1.28
(3)	2,000 - 5,000	25.53	84,738	3319.15	15.35	2.64	47.17	3.92
(4)	5,000 - 10,000	22.11	158,278	7158.66	13.29	4.94	60.46	8.86
(5)	10,000 - 20,000	22.28	321,842	14445.33	13.39	10.04	73.86	18.90
(6)	20,000 - 50,000	26.18	836,574	31954.70	15.74	26.10	89.59	45.00
(7)	50,000 - 100,000	11.71	809,305	69112.30	7.04	25.24	96.63	70.24
(8)	100,000 - 200,000	4.46	597,946	134068.61	2.68	18.65	99.31	88.89
(9)	200,000 - 300,000	0.76	181,270	238513.16	0.46	5.65	99.77	94.55
(10)	300,000 - 500,000	0.30	107,883	359610.00	0.18	3.37	99.95	97.91
(11)	500,000 or more	0.08	66,970	837125.00	0.05	2.09	100.00	100.00
	TOTAL	166.35	3,205,853	1,697,442.13	100.00	100.00		

Source: European Commission.

Table A.5 – Data for European Union (EU-14), 2000

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
							0.00	0.00
(1)	0 - 1,250	2397.63	970,812	404.90	53.78	4.34	53.78	4.34
(2)	1,250 - 2,000	380.80	606,620	1593.01	8.54	2.71	62.32	7.05
(3)	2,000 - 5,000	726.73	2,395,330	3296.04	16.30	10.71	78.62	17.76
(4)	5,000 - 10,000	409.08	2,916,112	7128.46	9.18	13.04	87.80	30.80
(5)	10,000 - 20,000	303.50	4,245,523	13988.54	6.81	18.98	94.60	49.78
(6)	20,000 - 50,000	184.10	5,541,106	30098.35	4.13	24.77	98.73	74.55
(7)	50,000 - 100,000	41.70	2,797,842	67094.53	0.94	12.51	99.67	87.06
(8)	100,000 - 200,000	10.72	1,433,147	133689.09	0.24	6.41	99.91	93.47
(9)	200,000 - 300,000	2.13	513,664	241156.81	0.05	2.30	99.96	95.77
(10)	300,000 - 500,000	1.27	478,198	376533.86	0.03	2.14	99.99	97.90
(11)	500,000 or more	0.61	468,683	768332.79	0.01	2.10	100.00	100.00
	TOTAL	4,458.27	22,367,037	1,643,316.39	100.00	100.00		

Source: European Commission.

Table A.6 – Data for European Union (EU-15), 2001

	Subsidy range	Number in group	Group total subsidy ('000s €)	Group mean subsidy ('000s €)	Relative frequency (%)		Cumulative Frequency (%)	
	('000s €)	('000s)			No. of farms	Amt. of Subsidy	No. of farms	Amt. of Subsidy
(1)	Less than 0	1.80	-2,681				0.00	0.00
(2)	0 - 1,250	2327.39	992,600	426.49	51.76	3.99	51.76	3.99
(3)	1,250 - 2,000	384.49	612,308	1592.52	8.55	2.46	60.31	6.45
(4)	2,000 - 5,000	715.20	2,328,672	3255.97	15.91	9.35	76.22	15.80
(5)	5,000 - 10,000	464.17	3,254,071	7010.52	10.32	13.07	86.55	28.87
(6)	10,000 - 20,000	325.01	4,575,726	14078.72	7.23	18.38	93.77	47.25
(7)	20,000 - 50,000	212.73	6,432,698	30238.79	4.73	25.84	98.51	73.10
(8)	50,000 - 100,000	50.34	3,371,653	66977.61	1.12	13.54	99.62	86.64
(9)	100,000 - 200,000	12.40	1,645,294	132685.00	0.28	6.61	99.90	93.25
(10)	200,000 - 300,000	2.29	552,930	241454.15	0.05	2.22	99.95	95.47
(11)	300,000 - 500,000	1.42	534,689	376541.55	0.03	2.15	99.98	97.62
(12)	500,000 or more	0.76	593,049	780327.63	0.02	2.38	100.00	100.00
	TOTAL (all ranges)	4,498.00	24,891,009					
	TOTAL (ranges 2 - 12)	4,496.20	24,893,690	1,654,588.95	1240.98	100.00		

Source: European Commission.

Table A.7 – Data for United States, 2001

	Mean subsidy	% of farms	# farms	Total subsidy	% of subsidy	Cum% farms	Cum% subsidy
0	0	59.05	1,269,397.00	0	0.00	59.05	0.00
1 - 10,000	579	22.52	484,157.30	280,327,076.70	4.55	81.57	4.55
10,000 - 50,000	3,765	8.60	184,860.06	695,998,125.90	11.30	90.17	15.85
50,000 - 100,000	10,399	3.28	70,422.88	732,327,529.12	11.89	93.45	27.75
100,000 - 250,000	18,307	3.69	79,225.74	1,450,385,622.18	23.55	97.13	51.30
250,000 - 500,000	38,703	1.64	35,211.44	1,362,788,362.32	22.13	98.77	73.43
> 500,000	61,953	1.23	26,408.58	1,636,090,756.74	26.57	100.00	100.00
TOTAL	133,706	100.00	2,149,683	6,157,917,472.96	100.00		

Source: USDA Agricultural Income and Finance Outlook, Sept. 2002, p. 26-27.

Table A.8 – Data for Brazil, 2001

	Quintile	Income share	Cumulative distribution
	0	0	0
Gini	20	2.40	2.40
60.7	40	5.92	8.32
	60	10.36	18.68
	80	18.14	36.83
	100	63.17	100.00

Source: World Bank World Development Indicators (2004).

Note: Data is for 1998, and for income data ranked per capita.